

## Practice Problems

1. Determine the molar mass of the following compounds:

$$\text{HBr} \quad 81 \text{ g/mol}$$

$$\text{HCl} \quad 36.5 \text{ g/mol}$$

$$\text{Mg}_3(\text{PO}_4)_2 \quad 262 \text{ g/mol}$$

$$\text{H}_2\text{SO}_4 \quad 98 \text{ g/mol}$$

2. Determine the number of moles in each of the following:

$$632 \text{ g Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$$

$$294 \text{ g H}_3\text{PO}_4$$

$$990 \text{ g HCl}$$

$$\frac{632 \text{ g}}{158 \text{ g}} = 4.0 \text{ mol} \quad \frac{294 \text{ g H}_3\text{PO}_4 \times 1 \text{ mol H}_3\text{PO}_4}{98 \text{ g H}_3\text{PO}_4} = 3.0 \text{ mol} \quad \frac{990 \text{ g HCl} \times 1 \text{ mol}}{36.5 \text{ g}} = 27.1 \text{ mol}$$

3. Determine the number of representative particles in the following:

$$1.4 \text{ mol HBr}$$

$$0.26 \text{ mol Fe}$$

$$2.74 \text{ mol CO}_2$$

$$1.4 \text{ mol HBr} \times \frac{81 \text{ g HBr}}{1 \text{ mol HBr}} = 113.4 \text{ g HBr} \quad 0.26 \text{ mol Fe} \times \frac{56 \text{ g Fe}}{1 \text{ mol}} = 14.6 \text{ g Fe} \quad 2.74 \text{ mol CO}_2 \times \frac{44 \text{ g}}{1 \text{ mol}} = 120.6 \text{ g CO}_2$$

4. Calculate the mass of NaOH is needed to react with 196 g of  $\text{H}_3\text{PO}_4$  in order to produce water and sodium phosphate according to the following unbalanced reaction:



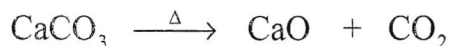
$$196 \text{ g H}_3\text{PO}_4 \times \frac{1 \text{ mol H}_3\text{PO}_4}{98 \text{ g H}_3\text{PO}_4} \times \frac{3 \text{ mol NaOH}}{1 \text{ mol H}_3\text{PO}_4} \times \frac{40 \text{ g NaOH}}{1 \text{ mol NaOH}} = 240 \text{ g NaOH}$$

5. Calculate the mass of  $\text{O}_2$  that is needed to react with 117 g Fe to make iron (III) oxide?



$$117 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{56 \text{ g Fe}} \times \frac{3 \text{ mol O}_2}{4 \text{ mol Fe}} \times \frac{32 \text{ g O}_2}{1 \text{ mol O}_2} = 50.1 \text{ g O}_2$$

6. Calcium carbonate,  $\text{CaCO}_3$ , decomposes and produces 2.26g calcium oxide,  $\text{CaO}$ . If the theoretical yield is 2.68g, what is the percent yield?



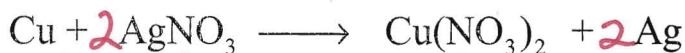
$$\frac{2.26 \text{ g CaO}}{2.68 \text{ g CaO}} \times 100\% = 84.3\%$$

7. Calculate the mass of  $\text{NaOH}$  produced when 254 grams of  $\text{Na}_2\text{CO}_3$  are reacted according to the following unbalanced reaction:



$$254 \text{ g Na}_2\text{CO}_3 \times \frac{1 \text{ mol Na}_2\text{CO}_3}{106 \text{ g Na}_2\text{CO}_3} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol Na}_2\text{CO}_3} \times \frac{40 \text{ g NaOH}}{1 \text{ mol NaOH}} = 191.7 \text{ g NaOH}$$

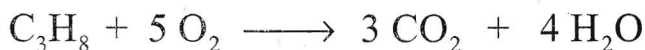
8. Calculate the mass of  $\text{Cu}$  needed to produce 2.25 g  $\text{Ag}$  according to the following unbalanced reaction:



$$2.25 \text{ g Ag} \times \frac{1 \text{ mol Ag}}{108 \text{ g Ag}} \times \frac{1 \text{ mol Cu}}{2 \text{ mol Ag}} \times \frac{63.5 \text{ g Cu}}{1 \text{ mol Cu}} = 0.66 \text{ g Cu}$$



9. Calculate the volume of oxygen gas needed to produce 6.5 Liters of  $\text{CO}_2$  according to the following reaction:



$$6.5 \text{ L CO}_2 \times \frac{1 \text{ mol CO}_2}{22.4 \text{ L}} \times \frac{5 \text{ mol O}_2}{3 \text{ mol CO}_2} \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = 10.8 \text{ L O}_2$$

10. For the following pairs, circle the one in which particles are moving the fastest:

- a. A liquid at 50 °C or A liquid at 100 °C  
 b. A solid at 50 °C or A liquid at 50 °C  
 c. A solid at 100 °C or A gas at 50 °C  
 d. He gas at 30 °C or Kr gas at 30 °C

11. Why is the Kelvin temperature scale more appropriate than the Celcius or Farenheit scales when thinking about KMT?

The Kelvin Temp is directly proportional to the amt of KE.

12. What are STP conditions?

Standard Temp = 273 K or 0 °C  
 " " Pressure = 760 mmHg or 1 atm

13. The initial temperature of a gas is 43 °C. Calculate the final temperature if the volume changes from 500 mL to 350 mL at constant pressure?

$$\begin{array}{r} 273 \\ 43 \\ \hline 316 \end{array}$$

$$\frac{(1)(500 \text{ mL})}{316 \text{ K}} = \frac{(1)(350 \text{ mL})}{x} \quad x = 221.2 \text{ K}$$

14. Calculate the original volume of a gas at -10 °C if the final volume of gas is 200 gallons at 25 °C and pressure is held constant?

$$\frac{(1)(x)}{263 \text{ K}} = \frac{(200 \text{ gal})(1)}{298 \text{ K}} = 176.5 \text{ gal}$$

15. Calculate the final pressure on a balloon if its volume changes from 250 ft<sup>3</sup> at 770 mm Hg to 1000 ft<sup>3</sup> with constant temperature?

$$\frac{(770 \text{ mmHg})(250 \text{ ft}^3)}{1} = \frac{(x)(1000 \text{ ft}^3)}{1} \quad 192.5 \text{ mmHg}$$



16. A rigid vessel of gas at STP is heated to 900°C. Calculate the new pressure.

$$\frac{(1 \text{ atm})(1)}{273 \text{ K}} = \frac{(x)(1)}{1173 \text{ K}} \quad 4.3 \text{ atm}$$

17. Underline the solvent in each of the following solutions

- A solution containing 10.0 g of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) and 500.0 g of water
- A solution containing 60.0 mL of ethyl alcohol and 30.0 mL of methyl alcohol

18. Complete the following table using the combined gas law:

Parameter	Initial	Final
Temperature	23°C <del>296 K</del>	58°C <del>331 K</del>
Volume	360 mL	150 mL
Pressure	230 torr	<del>279.7</del> <del>617.3 Torr</del> $\frac{150}{331}$
Temperature	Standard <del>273 K</del>	105°C <del>378 K</del>
Volume	5 L	? <del>3.46 L</del>
Pressure	Standard <del>1 atm</del>	2 atm
Temperature	30°C <del>303 K</del>	Standard <del>273 K</del>
Volume	300 mL	? <del>282.7</del>
Pressure	795 mm Hg	Standard <del>760 atm</del>

19. Why does water not dissolve motor oil?

water is a polar solvent and oil is nonpolar ~~comp.~~

20. In which solution is the solubility of a gas higher – cold water or hot water?

cold water

21. What three things can you do to get sugar to dissolve faster in water?

- ① heat the water
- ② stir the solution
- ③ Crush ~~the~~ (powder) the sugar

22. When a solute is added to water, what happens to the freezing point? To the boiling point?

fp is depressed  
bp is elevated.

23. Which will freeze at a lower temperature – a 1.5 m solution of NaCl or a 1.5 m solution of  $MgCl_2$ ?

The  $MgCl_2$  because it dissociate into about 3 particles where NaCl will be 2

24. Which will boil at a higher temperature – a 1.5 m solution of  $C_6H_{12}O_6$  or a 1.5 m solution of NaCl?

The NaCl will boil higher because it is an electrolyte and the sugar is a molecular compound

25. Calculate the molarity of a solution if 236g of HI is dissolved in 17,500mL of solution?

$$M = \frac{(236g HI)}{(128.51g HI)} \times \frac{1}{17.5 L} = 0.10 M HI$$

26. Determine the mass of solute in 2000mL of a 0.25M solution of  $CuSO_4$ .

$$0.25 = \frac{\left(\frac{x}{159.5g}\right)}{2 L} = 79.8g CuSO_4$$

27. Calculate the molarity of 114g  $Al_2(SO_4)_3$  in 1500mL of solution.

$$M = \frac{(114g Al_2(SO_4)_3)}{(342g)} \times \frac{1}{1.5} = .22 M Al_2(SO_4)_3$$

28. Calculate the weight of KBr needed to make 200g of a 5% solution.

$$5.0\% = \frac{x}{200g} \times 100\% = 10g KBr$$

29. Calculate the mass of solute is needed to make 350mL of a 0.1M solution of  $C_2H_5OH$ .

$$0.1 M = \frac{\left(\frac{x}{46g}\right)}{.35 L} = 1.5g C_2H_5OH$$

30. Calculate the molality of a solution in which 115g  $AlCl_3$  in 1500g water.

$$m = \frac{\left(\frac{115g AlCl_3}{133.5g AlCl_3}\right)}{1.5 Kg} = 0.57 m$$

31. What would be the freezing point and boiling point of the solution in #18

$$\Delta T_f = (0.57m) \left(\frac{1.86^\circ C}{1 mol}\right) (4) = 4.3^\circ C$$

$$\Delta T_b = (0.57m) \left(\frac{.51^\circ C}{1m}\right) (4) = 1.17^\circ C$$

$$0^\circ C - 4.3 = -4.3^\circ C$$

$$100^\circ C + 1.17^\circ C = 101.2^\circ C$$

32. Calculate the pH and pOH of the following solutions:

$0.00001\text{M HNO}_3$   $14.0 - 5.0 = 9.0$   $\text{pH} = 5$   $0.00254\text{M HCl}$   $\text{pH} = 2.59$   $\text{pOH} = 11.40$   
 $0.001\text{M KOH}$   $14.00 - 3.00 = 11.00$   $0.0035\text{M H}_2\text{SO}_4$   $[\text{H}^+] = 2 \times 0.0035 = .007$   
 $-\log [0.001] = \text{pOH} = 3$   $-\log [0.007] = 2.15$   $\text{pOH} = 11.85$   
 $0.00002\text{M HCl}$   $14.00 - 4.70 = 9.30$   $0.00044\text{M H}_2\text{SO}_4$   $[\text{H}^+] = 2 \times 0.00044 = 8.8 \times 10^{-4}$   
 $-\log [0.00002] = 4.70$   $\text{pOH} = 9.30$   $-\log [8.8 \times 10^{-4}] = 3.06$   
 33. Calculate the pOH, hydronium ion, and hydroxide ion concentration for a solution with a pH of 5 and a solution with a pH of 12.35.

pH = 5  $\text{pOH} = 9$   $[\text{OH}^-] = 1 \times 10^{-9}$   $[\text{H}^+] = 1 \times 10^{-5}$   
 pH = 12.35  $\text{pOH} = 1.65$   $[\text{H}^+] = 4.47 \times 10^{-13}$   $[\text{OH}^-] = 2.23 \times 10^{-2}$   
 34. Identify the conjugate base for the following:

- a.  $\text{HCl}$   $\text{Cl}^-$   
 b.  $\text{H}_2\text{SO}_4$   $\text{HSO}_4^-$  or  $\text{SO}_4^{2-}$   
 c.  $\text{H}_2\text{O}$   $\text{OH}^-$

35. Identify the conjugate acid for the following

- a.  $\text{NO}_3^-$   $\text{HNO}_3$   
 b.  $\text{NH}_3$   $\text{NH}_4^+$   
 c.  $\text{H}_2\text{PO}_4^-$   $\text{H}_3\text{PO}_4$   
 d.  $\text{H}_2\text{O}$   $\text{H}_3\text{O}^+$

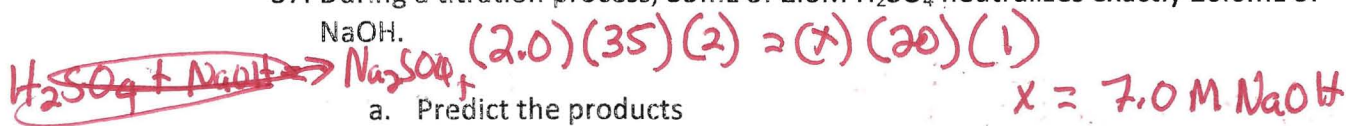
36. Label the acid, base, conjugate acid and conjugate base for the following:

- a.  $\text{HCN}(\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{CN}^-(\text{aq})$   
 acid base conj acid  $\rightarrow$  conj base  
 b.  $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$   
 base acid conj acid conj base



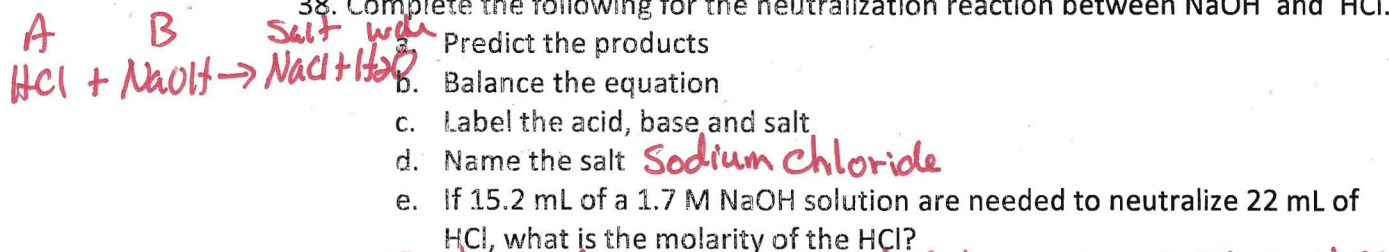


37. During a titration process, 35mL of 2.0M  $H_2SO_4$  neutralizes exactly 20.0mL of NaOH.



- Predict the products
- Balance the equation
- Label the acid, base and salt
- Name the salt **Sodium sulfate**
- Calculate molarity of the base solution.

38. Complete the following for the neutralization reaction between NaOH and HCl.



$$(1.7)(1)(15.2) = (x)(1)(22) \quad x = 1.17 \text{ M HCl}$$

39. For the following equations:

- Assign oxidation numbers to all atoms
- Identify which element is oxidized and which is reduced

Oxidation

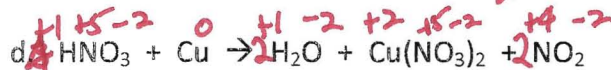
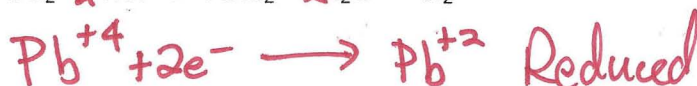
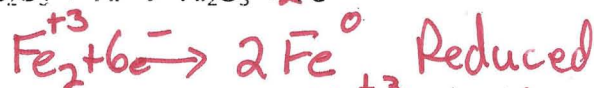
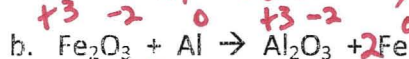
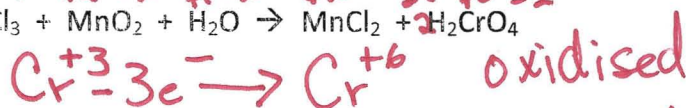
Is

Lose

Reduction

Is

Gain



40. Use the solubility curve chart to answer the following:

- a. How many grams of  $\text{Ce}_2(\text{SO}_4)_3$  will dissolve in 100 g  $\text{H}_2\text{O}$  at  $10^\circ\text{C}$ ? **14g**
- b. How many grams of  $\text{NaNO}_3$  will dissolve in 100 g  $\text{H}_2\text{O}$  at  $60^\circ\text{C}$ ? **123g**
- c. How many grams of  $\text{NH}_3$  will dissolve in 100 g  $\text{H}_2\text{O}$  at  $90^\circ\text{C}$ ? **10g**
- d. Identify the following solutions as saturated, unsaturated or supersaturated:
- i. A solution of  $\text{KClO}_3$  at  $40^\circ\text{C}$  contains 45 g in 100 g  $\text{H}_2\text{O}$ . **Supersaturated**
  - ii. A solution of  $\text{NH}_4\text{Cl}$  at  $40^\circ\text{C}$  contains 45 g in 100 g  $\text{H}_2\text{O}$ . **Saturated**
  - iii. A solution of  $\text{KNO}_3$  at  $40^\circ\text{C}$  contains 45 g in 100 g  $\text{H}_2\text{O}$ . **unsaturated**
- e. How many grams of  $\text{KNO}_3$  can be added to 100 g of  $\text{H}_2\text{O}$  if the temperature is increased from  $0^\circ\text{C}$  to  $60^\circ\text{C}$ ?  
**100 101g - 15g = 86g  $\text{KNO}_3$**
- f. How many grams of  $\text{KCl}$  will precipitate out of 100 g of water that is cooled from  $80^\circ\text{C}$  to  $20^\circ\text{C}$ ?  
**50g - 22g = 28g  $\text{KCl}$**